5.0 Rogue River Basin Hydrologic Model

5.1 Introduction

Computer simulations were performed to evaluate the hydrologic effects of Reclamation activities as defined in the proposed action. The computer model is described in detail in Little Butte and Bear Creek Surface Water Distribution Model, *Draft* - Model Version March 26, 2003 (Reclamation 2003). Pisces was developed by Reclamation's Pacific Northwest Regional Office for viewing and portraying model documention. A CD copy of Pisces and the associated database can be found in Appendix B. Modeled system inflows were developed from measured flows and reservoir contents from water years 1962 through 1999. Two scenarios were modeled:

1. The "with Reclamation" scenario simulates the current facilities and operations of Little Butte and Bear Creeks in the Rogue River basin and of Jenny Creek and Fourmile Creek diversions in the Klamath River basin. Federal and non-Federal facilities are included in the scenario. ***The proposed action is the operations of Federal facilities within the "with Reclamation" scenario***.
2. The "without Reclamation" scenario removes the operation of Reclamation storage facilities and Reclamation transbasin diversions from the "with Reclamation" scenario.

The "without Reclamation" scenario differs from the "with Reclamation" scenario in that:

- Reclamation reservoirs Emigrant, Howard Prairie, Hyatt, Agate, and Keene Creek do not operate and, instead, pass flows
- Diversions from the South Fork of Little Butte Creek in the Rogue River basin to Howard Prairie Lake in the Klamath River basin do not occur. These diversions are the Dead Indian Collection Canal and the South Fork Little Butte Collection Canal near Pinehurst (Deadwood Tunnel)
- The Howard Prairie Delivery Canal and Green Springs Tunnel and spillway do not operate. These facilities would normally transport combined flows from Howard Prairie Lake and Hyatt Reservoir, and the partially intercepted flows from Soda Creek, Little Beaver Creek, and Keene Creek in the Klamath River basin to Emigrant Reservoir in the Rogue River basin.

Reclamation reservoirs in the "without Reclamation" scenario forego their right to fill. Natural flow which would have been stored, is made available for distribution to other water rights holders in priority. Private facilities respond to the absence of Reclamation facility operations.

The major facilities and modeled operations for each scenario are listed in Table 5-1, Table 5-2, and Table 5-3.

Table 5-1. Modeled Storage Facilities

Reclamation Reservoirs	With Reclamation	Without Reclamation
Emigrant Lake	stores and releases Project water	does not operate
Howard Prairie Lake	stores and releases Project water	does not operate
Hyatt Reservoir	stores and releases Project water	does not operate
Agate Lake	re-regulates private water	does not operate
Private Reservoirs	**With Reclamation**	**Without Reclamation**
Fourmile Lake	stores and releases private water	stores and releases private water
Fish Lake	stores and releases private water	stores and releases private water

Table 5-2. Modeled Irrigation Diversions

Reclamation Project Diversions	With Reclamation	Without Reclamation
TID diverts from Emigrant and Bear Creeks through Ashland Canal, East Lateral (serving East and West Canals), and Talent Canal at Oak Street Diversion Dam	natural flow and stored flow from Project reservoirs	natural flow
MID diverts from Bear Creek through Phoenix Canal	natural flow and stored flow from Project reservoirs	natural flow
RRVID diverts from Bear Creek through Bear Creek Canal at Jackson Street Diversion	natural flow and stored flow from Project reservoirs	natural flow

Private Diversions	With Reclamation	Without Reclamation
RRVID and MID divert from North Fork Little Butte Creek into Joint System Canal	natural flow and stored flow from Fourmile and Fish Lakes	natural flow and stored flow from Fourmile and Fish Lakes
RRVID and MID divert from South Fork Little Butte Creek into Joint System Canal	natural flow	natural flow

Table 5-3. Modeled Transbasin Diversion Facilities

Reclamation Diversions	With Reclamation	Without Reclamation
Dead Indian Collection Canal and South Fork Little Butte Collection Canal near Pinehurst (Deadwood Tunnel) divert from tributaries to South Fork Little Butte Creek in Rogue River basin to Howard Prairie Lake in Klamath River basin.	operates	does not operate
Howard Prairie Delivery Canal and Green Springs Tunnel and spillway transport the combined flows from Howard Prairie Lake and Hyatt Reservoir, and intercepted flows from Soda Creek, Little Beaver Creek, and Keene Creek in Klamath River basin to Emigrant and Bear Creeks in Rogue River basin.	operates	does not operate
Private Canals	**With Reclamation**	**Without Reclamation**
Cascade Canal delivers flows from Fourmile Lake in Klamath River basin to Fish Lake in Rogue River basin.	operates	operates

5.2 Determination of Flow Impacts

Modeled flows are provided at the seven calibration locations on Emigrant, Bear and Little Butte Creeks described in Table 5-4 and shown on Figure 5-1.

Table 5-4. Model Calibration Locations

Gage Name	USGS	Location
Emigrant Creek below Emigrant Dam	14350000	Emigrant/Bear Creek RM 29.2
Bear Creek below Ashland Creek[1]	14354200	Ashland Creek enters Bear Creek at RM 21.1
Bear Creek at Medford	14357500	Bear Creek RM 9.9
Bear Creek above Jackson Creek[2]	14358700	Jackson Creek enters Bear Creek at RM 2.0
North Fork Little Butte Creek below Fish Lake	14342500	Fish Lake Dam is at Little Butte Creek RM 15.8
South Fork Little Butte Creek near Lake Creek, above south intake to Joint System Canal[3].	14341500	Little Butte Creek RM 18.1
Little Butte Creek at Lake Creek[4], below confluence of North and South Forks	14346700	confluence of North and South Forks is at Little Butte Creek RM 17.2

[1] available starting in water year 1990
[2] available water year 1969 only
[3] discontinued in water year 1982
[4] discontinued in water year 1989; restarted in water year 2001

Modeled average monthly flows at the 10, 50, and 90 percent exceedance levels for the "without Reclamation" and the "with Reclamation" scenarios are shown in Table 5-5, Table 5-6 and Table 5-7 .

The flow effects due to the proposed action (also shown in Table 5-5, Table 5-6 and Table 5-7) are determined by subtracting the "without Reclamation" scenario flows from the "with Reclamation" scenario flows. Although this approach does not distinguish flow differences on a year by year basis, it can be used to evaluate the magnitude and trends of the proposed action effects.

An exceedance level is the probability that a value is equaled or exceeded. For example, in Table 5-5, at Bear Creek at Medford, for the "with Reclamation" scenario, there is a 10 percent probability that modeled average monthly October flows will equal or exceed 52 cfs. There is a 50 percent probability that modeled average monthly October flows will equal or exceed 30 cfs. There is a 90 percent probability that modeled average monthly October flows will equal or exceed 12 cfs.

Flows at the 10 percent level are interpreted as high flows; 50 percent level flows are median flows; and 90 percent level flows are low flows.

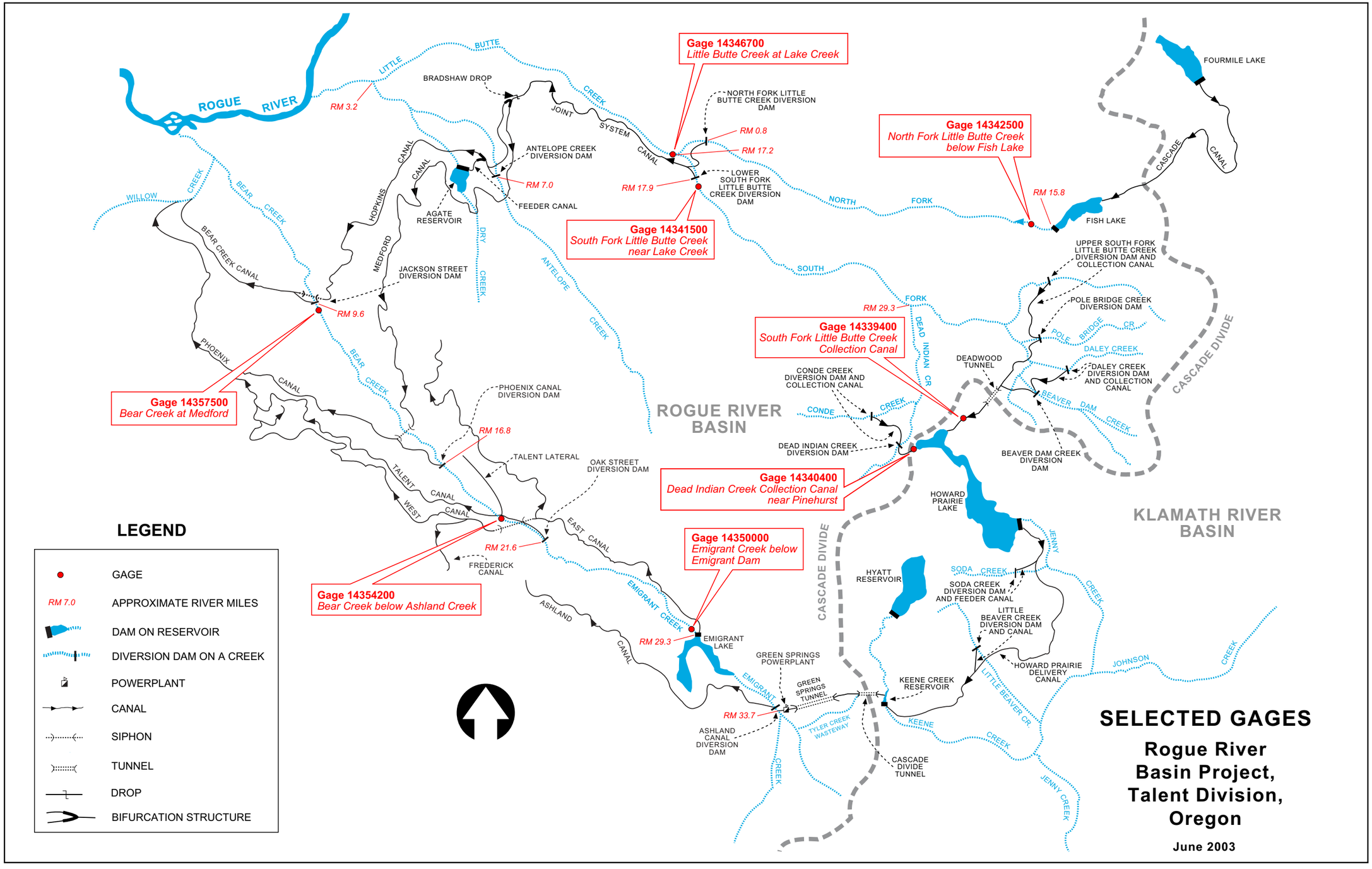
ROGUE RIVER
LITTLE BUTTE CREEK
RM 3.2
BRADSHAW DROP
JOINT SYSTEM CANAL
ANTELOPE CREEK DIVERSION DAM
RM 7.0
FEEDER CANAL
AGATE RESERVOIR
HOPKINS CANAL
MEDFORD CANAL
DRY CREEK
ANTELOPE CREEK
Gage 14346700
Little Butte Creek at Lake Creek
NORTH FORK LITTLE BUTTE CREEK DIVERSION DAM
RM 0.8
RM 17.2
RM 17.9
LOWER SOUTH FORK LITTLE BUTTE CREEK DIVERSION DAM
Gage 14341500
South Fork Little Butte Creek near Lake Creek
NORTH FORK
Gage 14342500
North Fork Little Butte Creek below Fish Lake
RM 15.8
FISH LAKE
FOURMILE LAKE
CASCADE CANAL
CASCADE DIVIDE
UPPER SOUTH FORK LITTLE BUTTE CREEK DIVERSION DAM AND COLLECTION CANAL
POLE BRIDGE CREEK DIVERSION DAM
POLE BRIDGE CR
DALEY CREEK
DALEY CREEK DIVERSION DAM AND COLLECTION CANAL
BEAVER DAM CREEK
BEAVER DAM CREEK DIVERSION DAM
DEADWOOD TUNNEL
SOUTH FORK
RM 29.3
Gage 14339400
South Fork Little Butte Creek Collection Canal
DEAD INDIAN CR
CONDE CREEK DIVERSION DAM AND COLLECTION CANAL
CONDE CREEK
DEAD INDIAN CREEK DIVERSION DAM
Gage 14340400
Dead Indian Creek Collection Canal near Pinehurst
HOWARD PRAIRIE LAKE
JENNY CREEK
HYATT RESERVOIR
SODA CREEK
SODA CREEK DIVERSION DAM AND FEEDER CANAL
LITTLE BEAVER CREEK DIVERSION DAM AND CANAL
HOWARD PRAIRIE DELIVERY CANAL
JOHNSON CREEK
KEENE CREEK RESERVOIR
LITTLE BEAVER CR
KEENE CREEK
CASCADE DIVIDE TUNNEL
ROGUE RIVER BASIN
KLAMATH RIVER BASIN
WILLOW CREEK
BEAR CREEK
BEAR CREEK CANAL
PHOENIX CANAL
RM 9.6
JACKSON STREET DIVERSION DAM
Gage 14357500
Bear Creek at Medford
PHOENIX CANAL DIVERSION DAM
RM 16.8
TALENT LATERAL
OAK STREET DIVERSION DAM
TALENT WEST CANAL
EAST CANAL
RM 21.6
FREDERICK CANAL
Gage 14354200
Bear Creek below Ashland Creek
Gage 14350000
Emigrant Creek below Emigrant Dam
EMIGRANT CREEK
RM 29.3
EMIGRANT LAKE
ASHLAND CANAL
GREEN SPRINGS POWERPLANT
GREEN SPRINGS TUNNEL
EMIGRANT
RM 33.7
ASHLAND CANAL DIVERSION DAM
TYLER CREEK WASTEWAY
LEGEND
GAGE
RM 7.0
APPROXIMATE RIVER MILES
DAM ON RESERVOIR
DIVERSION DAM ON A CREEK
POWERPLANT
CANAL
SIPHON
TUNNEL
DROP
BIFURCATION STRUCTURE
SELECTED GAGES
Rogue River Basin Project, Talent Division, Oregon
June 2003

Figure 5-1

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5.2.1 Emigrant and Bear Creeks

Emigrant and Bear Creeks modeled flows are shown in Table 5-5, Table 5-6, and summarized below.

Months	Effects Due to Reclamation	Reasons
November – May	Decrease flows	Diversion and storage
June	Decrease high flows Increase low flows	Storage and release
July – October	Increase flows	Release and return flows

November through May

Reclamation activities decrease flows November through May due to storing natural flow in Emigrant Reservoir. In other words, "with Reclamation" flows are generally less than "without Reclamation" flows.

June

Reclamation activities tend to decrease high flows and increase low flows in Bear Creek in June. "With Reclamation" high flows are less than "without Reclamation" high flows in June due to storing natural flow in Emigrant Reservoir, especially when natural inflows to Bear Creek and its tributaries downstream from the dam are sufficient to satisfy irrigation requirements. In Emigrant Creek below Emigrant Dam, flow reduction occurs below the 6 percent exceedence level.

"With Reclamation" low flows are greater than "without Reclamation" low flows in June due to the release of natural flows and stored flows from Project reservoirs, including transbasin diversions.

July through October.

Reclamation activities increase flows July though October.

"With Reclamation" flows are greater than "without Reclamation" flows during this period due to the release of natural flows and stored flows from Project reservoirs,

including transbasin diversions. Return flows from irrigated lands also contribute to flow increases.

5.2.2 South Fork Little Butte Creek Near Lake Creek

South Fork Little Butte Creek near Lake Creek modeled flows are shown in Table 5-7 and summarized below.

Months	Effects Due to Reclamation	Reasons
November – May	Decrease flows	Diversion and storage
June	Decrease high flows Little effect on median and low flows	Diversion and storage
July – October	Decrease flows	Diversion and storage

November through May

Reclamation activities decrease flows in the South Fork Little Butte Creek near Lake Creek November through May.

"With Reclamation" flows are less than "without Reclamation" flows during this period due to the transbasin diversion of water through the Dead Indian and the South Fork Little Butte Collection Canals. Transbasin diversions occur throughout the year, but decline throughout the summer.

June

Reclamation activities decrease high flows and have little effect on median and low flows in the South Fork Little Butte Creek near Lake Creek November through May.

"With Reclamation" high flows are less than "without Reclamation" high flows in June due to the transbasin diversion of water through the Dead Indian and the South Fork Little Butte Collection Canals.

July through October

Reclamation activities decrease flows insignificantly in the South Fork Little Butte Creek near Lake Creek July through October.

"With Reclamation" flows are slightly less than "without Reclamation" flows because small or infrequent transbasin diversions occur through the Dead Indian and the South Fork Little Butte Collection Canals during this period.

5.2.3 Little Butte Creek at Lake Creek

Little Butte Creek at Lake Creek modeled flows are shown in Table 5-7 and summarized below.

Months	Effects Due to Reclamation	Reasons
November – December	Increase low flows Small effect on median and high flows	Diversion and storage
January – May	Decrease flows	Diversion
June – October	Increase flows	Release

November and December

Reclamation activities and private activities in response to Reclamation's operations increase low flows in November and December and have only small effects on median and high flows.

Diversions through the Dead Indian and the South Fork Little Butte Collection Canals during low flow periods are small as shown in the table below and do not contribute significantly to low flow effects of the "with Reclamation" scenario at Lake Creek. Therefore, the "with Reclamation" low flows are greater than "without Reclamation" low flows for November and December because, in the "without Reclamation" scenario, water is being stored in Fish Lake in an effort to recover from large summer drawdowns.

Average Daily Diversion from South Fork to Howard Prairie(cfs)

Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep
3	10	17	25	22	37	24	38	20	7	2	1

The table shows historic observed values for water years 1991 to 1999. Gages: Dead Indian 14340400 and Deadwood Tunnel 14339400

In the "with Reclamation" scenario, median and high flows for November and December are similar to median and high "without Reclamation" flows because, in the "with Reclamation" scenario, the flow decreasing effects of diversions through the Dead Indian and the South Fork Little Butte Collection Canals are offset by the non-Federal release of stored water from Fish Lake.

January through May

Reclamation activities and private activities in response to Reclamation's operations decrease January through May flows in Little Butte Creek at Lake Creek.

"With Reclamation" flows are generally less than "without Reclamation" flows during this period due to the effects of diversions through the Dead Indian and South Fork Little Butte Collection Canals which are not offset by the release of stored water from Fish Lake.

June through October

Reclamation activities and private activities in response to Reclamation's operations increase June through October flows in Little Butte Creek at Lake Creek (Figure 5-1).

"With Reclamation" flows in Little Butte Creek are frequently less than "without Reclamation" flows due to private diversions into the Joint System Canal and Reclamation diversions in upper South Fork Little Butte Creek.

Table 5-5. Emigrant and Bear Creek Modeled Flow Effects

	Emigrant Creek below Emigrant Dam				Bear Creek below Ashland Creek				Bear Creek at Medford			
Percent Exceedance	"With Reclamation"	"Without Reclamation"	Flow Effects - Proposed Action	Flow Effects of Proposed Action - Percent of "Without Reclamation"	"With Reclamation"	"Without Reclamation"	Flow Effects - Proposed Action	Flow Effects of Proposed Action - Percent of "Without Reclamation"	"With Reclamation"	"Without Reclamation"	Flow Effects - Proposed Action	Flow Effects of Proposed Action - Percent of "Without Reclamation"
(%)	(cfs)	(cfs)	(cfs)	(%)	(cfs)	(cfs)	(cfs)	(%)	(cfs)	(cfs)	(cfs)	(%)
	October				**October**				**October**			
10	9	12	-3	-25	29	30	-1	-3	52	53	-1	-2
50	0	0	0		19	15	4	27	30	27	3	11
90	0	0	0		9	4	5	125	12	9	3	33
	November				**November**				**November**			
10	70	133	-63	-47	132	238	-106	-45	189	295	-106	-36
50	0	4	-4	-100	27	28	-1	-4	44	41	3	7
90	0	0	0		12	12	0	0	17	17	0	0
	December				**December**				**December**			
10	152	200	-48	-24	674	595	79	13	764	682	82	12
50	0	28	-28	-100	67	79	-12	-15	95	110	-15	-14
90	0	0	0		19	19	0	0	32	32	0	0
	January				**January**				**January**			
10	180	231	-51	-22	405	572	-167	-29	605	769	-164	-21
50	0	78	-78	-100	98	139	-41	-29	150	193	-43	-22
90	0	8	-8	-100	21	35	-14	-40	38	50	-12	-24
	February				**February**				**February**			
10	100	233	-133	-57	215	324	-109	-34	338	435	-97	-22
50	0	95	-95	-100	100	203	-103	-51	136	259	-123	-47
90	0	7	-7	-100	27	27	0	0	42	42	0	0
	March				**March**				**March**			
10	128	239	-111	-46	322	461	-139	-30	392	527	-135	-26
50	1	128	-127	-99	125	222	-97	-44	163	278	-115	-41
90	0	23	-23	-100	24	47	-23	-49	31	55	-24	-44

	Emigrant Creek below Emigrant Dam				Bear Creek below Ashland Creek				Bear Creek at Medford			
Percent Exceedance	"With Reclamation"	"Without Reclamation"	Flow Effects - Proposed Action	Flow Effects of Proposed Action - Percent of "Without Reclamation"	"With Reclamation"	"Without Reclamation"	Flow Effects - Proposed Action	Flow Effects of Proposed Action - Percent of "Without Reclamation"	"With Reclamation"	"Without Reclamation"	Flow Effects - Proposed Action	Flow Effects of Proposed Action - Percent of "Without Reclamation"
	April				**April**				**April**			
10	185	218	-33	-15	330	379	-49	-13	437	482	-45	-9
50	55	110	-55	-50	146	205	-59	-29	176	262	-86	-33
90	0	30	-30	-100	34	41	-7	-17	19	60	-41	-68
	May				**May**				**May**			
10	119	182	-63	-35	253	315	-62	-20	315	417	-102	-24
50	21	60	-39	-65	88	122	-34	-28	121	178	-57	-32
90	0	20	-20	-100	28	36	-8	-22	26	63	-37	-59
	June				**June**				**June**			
10	61	62	-1	-2	120	148	-28	-19	167	209	-42	-20
50	29	27	2	7	59	76	-17	-22	64	95	-31	-33
90	4	5	-1	-20	27	17	10	59	19	17	2	12
	July				**July**				**July**			
10	89	38	51	134	86	55	31	56	57	60	-3	-5
50	67	12	55	458	59	37	22	59	31	21	10	48
90	35	0	35		43	16	27	169	20	19	1	5
	August				**August**				**August**			
10	95	37	58	157	83	52	31	60	88	66	22	33
50	59	0	59		55	25	30	120	53	20	33	165
90	43	0	43		34	10	24	240	21	15	6	40
	September				**September**				**September**			
10	51	28	23	82	71	54	17	31	92	63	29	46
50	27	1	26	2600	31	16	15	94	53	27	26	96
90	5	0	5		5	0	5		25	14	11	79

Table 5-6. Emigrant and Bear Creek Modeled Flow Effects

Bear Creek above Jackson Creek				
Percent Exceedance	**"With Reclamation"**	**"Without Reclamation"**	**Flow Effects - Proposed Action**	**Flow Effects of Proposed Action - Percent of "Without Reclamation"**
(%)	(cfs)	(cfs)	(cfs)	(%)
	October			
10	80	75	5	7
50	45	37	8	22
90	15	7	8	114
	November			
10	208	309	-101	-33
50	60	53	7	13
90	38	28	10	36
	December			
10	766	684	82	12
50	97	113	-16	-14
90	34	36	-2	-6
	January			
10	605	769	-164	-21
50	150	193	-43	-22
90	38	50	-12	-24
	February			
10	338	435	-97	-22
50	136	259	-123	-47
90	42	42	0	0
	March			
10	392	527	-135	-26
50	163	278	-115	-41
90	31	55	-24	-44
	April			
10	432	486	-54	-11
50	174	266	-92	-35
90	19	59	-40	-68

Bear Creek above Jackson Creek				
Percent Exceedance	**"With Reclamation"**	**"Without Reclamation"**	**Flow Effects - Proposed Action**	**Flow Effects of Proposed Action - Percent of "Without Reclamation"**
	May			
10	330	431	-101	-23
50	138	188	-50	-27
90	24	63	-39	-62
	June			
10	190	241	-51	-21
50	93	119	-26	-22
90	19	1	18	1800
	July			
10	67	59	8	14
50	40	22	18	82
90	23	0	23	
	August			
10	106	70	36	51
50	73	18	55	306
90	24	0	24	
	September			
10	136	94	42	45
50	79	46	33	72
90	34	0	34	

Table 5-7. South Fork and Little Butte Creek Modeled Flow Effects

	South Fork Little Butte Creek Near Lake Creek				Little Butte Creek at Lake Creek			
Percent Exceedance	"With Reclamation"	"Without Reclamation"	Flow Effects - Proposed Action	Flow Effects of Proposed Action - Percent of "Without Reclamation"	"With Reclamation"	"Without Reclamation"	Flow Effects - Proposed Action	Flow Effects of Proposed Action - Percent of "Without Reclamation"
(%)	(cfs)	(cfs)	(cfs)	(%)	(cfs)	(cfs)	(cfs)	(%)
	October				October			
10	45	47	-2	-4	83	52	31	60
50	18	21	-3	-14	55	31	24	77
90	14	17	-3	-18	37	24	13	54
	November				November			
10	104	112	-8	-7	198	204	-6	-3
50	46	51	-5	-10	114	112	2	2
90	18	25	-7	-28	77	59	18	31
	December				December			
10	339	390	-51	-13	504	538	-34	-6
50	99	108	-9	-8	236	231	5	2
90	24	41	-17	-41	123	108	15	14

	South Fork Little Butte Creek Near Lake Creek				Little Butte Creek at Lake Creek			
Percent Exceedance	"With Reclamation"	"Without Reclamation"	Flow Effects - Proposed Action	Flow Effects of Proposed Action - Percent of "Without Reclamation"	"With Reclamation"	"Without Reclamation"	Flow Effects - Proposed Action	Flow Effects of Proposed Action - Percent of "Without Reclamation"
	January				January			
10	357	419	-62	-15	462	503	-41	-8
50	137	150	-13	-9	230	236	-6	-3
90	32	44	-12	-27	110	113	-3	-3
	February				February			
10	256	279	-23	-8	445	479	-34	-7
50	104	149	-45	-30	235	264	-29	-11
90	49	73	-24	-33	164	150	14	9
	March				March			
10	341	356	-15	-4	513	524	-11	-2
50	133	182	-49	-27	270	313	-43	-14
90	55	88	-33	-38	159	187	-28	-15
	April				April			
10	345	371	-26	-7	489	474	15	3
50	230	291	-61	-21	314	335	-21	-6

	South Fork Little Butte Creek Near Lake Creek				Little Butte Creek at Lake Creek			
Percent Exceedance	"With Reclamation"	"Without Reclamation"	Flow Effects - Proposed Action	Flow Effects of Proposed Action - Percent of "Without Reclamation"	"With Reclamation"	"Without Reclamation"	Flow Effects - Proposed Action	Flow Effects of Proposed Action - Percent of "Without Reclamation"
90	77	123	-46	-37	107	120	-13	-11
	May				**May**			
10	368	417	-49	-12	417	445	-28	-6
50	141	201	-60	-30	173	175	-2	-1
90	61	94	-33	-35	50	65	-15	-23
	June				**June**			
10	93	132	-39	-30	111	87	24	28
50	57	63	-6	-10	37	24	13	54
90	33	34	-1	-3	15	15	0	0
	July				**July**			
10	38	43	-5	-12	47	27	20	74
50	26	30	-4	-13	26	24	2	8
90	15	15	0	0	17	17	0	0
	August				**August**			
10	28	28	0	0	46	24	22	92

	South Fork Little Butte Creek Near Lake Creek				Little Butte Creek at Lake Creek			
Percent Exceedance	"With Reclamation"	"Without Reclamation"	Flow Effects - Proposed Action	Flow Effects of Proposed Action - Percent of "Without Reclamation"	"With Reclamation"	"Without Reclamation"	Flow Effects - Proposed Action	Flow Effects of Proposed Action - Percent of "Without Reclamation"
50	21	21	0	0	30	24	6	25
90	12	13	-1	-8	16	16	0	0
	September				September			
10	25	25	0	0	56	25	31	124
50	18	19	-1	-5	34	24	10	42
90	14	14	0	0	17	17	0	0